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Featuring

Winter Construction

Construction Cost Estimating

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BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XIII DECEMBER, 1926 Number 10

WINTER CONSTRUCTION

BY COL. S. E. THOMPSON, W. C. VOSS AND C. E. PATCH

(Presented November 17, 1926)

Col. Sanford E. Thompson *

MY first experience in "winter construction" was in the South. While this does not sound like cold weather, those of you who have been in North Carolina in winter know that it sometimes gets decidedly cold there. This was my first work in construction during the middle of my course at Tech, and was on the building of waterworks for the town of Durham, N. C. We were excavating a tail race in rock. The man in charge was an old masonry foreman of the South, and we drilled the holes by hand — negro drillers at $1 per day — and then put in dynamite. We wondered why the dynamite did not go off. Sometimes it would puff and make a small hole. Nobody knew what the trouble was, not even the engineers from the North. Finally, we discovered that the trouble was due to freezing of the dynamite. Of course, every one knows now that dynamite freezes at 42° to 46° F. We were trying to blast that rock with frozen dynamite. So the foreman used to build a wood fire beside the trench and we would warm up the dynamite to thaw it. It never blew up, so of course it was an absolutely safe procedure, and yet, somehow, I would not care to repeat the performance.

The recent growth of winter construction which has been taking place during the last few years has been greatly accelerated, if, in fact, it was not created, through analyses begun by Mr. Herbert Hoover. This was one of the natural sequences of our Committee on Elimination of Waste in Industry formed by Mr. Herbert Hoover in 1920 when he was president of the Federated American Engineering Societies, now

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* President, The Thompson & Lichtner Co., Inc., Engineers, 80 Federal Street, Boston, Mass.

the American Engineering Council. In our treatment on the Building Industry in the report "Waste in Industry,"* the fluctuations of employment in the building trades were brought out very vividly. This led Mr. Hoover later, in connection with the President's Unemployment Conference, to appoint a committee on seasonal operations in the construction industry. This committee, with the aid of the U. S. Department of Commerce and a few professional engineers, made very complete studies of various factors, including weather conditions, extent of seasonal construction, materials and supplies, remedies and other features.

This material, which includes our chapter on "Practicability of Continuous Construction Throughout the Year" is compiled in the volume "Seasonal Operation in the Construction Industries."*

In preparing the material which was designed to analyze the various factors to see how far contractors could go in overcoming difficulties of winter construction, and to determine the comparative merits and costs of construction in the different seasons, we corresponded with and interviewed various contractors in different parts of the country to find out their experience and to get comparative costs. In many cases we found that winter construction had actually cost less than summer construction. These findings were not theoretical, they were based on comparative records of different jobs nearly enough alike to give fair comparison.

In the first place, it was found that there were fewer poor days in winter, when work could not be done easily, than one generally supposes. For instance, the average time in New York City in the five months of winter during which the cold was excessive or storms were appreciable was fourteen days, taken over the ten-year period from 1913 to 1923. The average number of stormy days in the summer months was about five — not a very great difference.

Then we looked into the cost of winter construction and found from records that the increase in cost, due to specific items such as shovelling off snow, protecting materials, covering up the work, heating, etc., amounted, on the average, to about 3½ per cent of the cost of the completed structure, being a little more than this on small jobs, and a little less on large ones.

Now this is the direct loss which can be figured in dollars and cents, and if there were nothing to balance this, it would prove a severe handicap. We ask, then, why is it sometimes possible to do winter construction work at less than the cost in summer? The reason is this: in winter we have this excess direct cost, and we have the excess cost due to a little more delay on account of snow and occasional extremely cold days, but, on the other hand, there are advantages tending to counterbalance these charges. One of the most important of these is lower labor cost, due chiefly to the fact that labor is more plentiful in winter than in summer.

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* Published by McGraw-Hill Book Company.

Facts brought out from studies by the Boston Building Congress showed that during certain periods of the winter members of the building trades were working only about 50 per cent of the time. When there are workmen in large excess of the demand, and the men realize that there is competition for their jobs, they naturally work more diligently. This is, of course, something with which you men, as engineers and contractors, are perfectly familiar. If the supply of labor is plentiful, a man will work harder because he knows that there is somebody ready to take his job if he loses it. Production records of a New York builder, for example, showed that the average day's work of a bricklayer in winter was from 10 to 20 per cent greater than in summer — there was this actual increase in production in winter over summer.

In answer to our inquiries, some of the most accurate data came from the Aberthaw Construction Company here in Boston. Data from them and other builders indicated that in bricklaying there was a reduction in cost of labor in winter of about 15 per cent; in reinforcement a reduction in labor of about 9 per cent; in concreting about 11 per cent. Form construction was a little higher than in summer because the weather affected it more than the others.

In materials, as well as labor, there is the advantage of lower costs in winter due to the smaller quantity of materials sold. For example, in a study made of lumber sales, it was found that twice as much lumber was sold in the summer six months as in the winter six months. Here, again, we have the condition of the greater supply in the winter months and the naturally lower cost. Orders also can be filled more quickly and to better advantage. Transportation is apt to be quicker in the winter months with fewer consequent delays in shipments.

And then, of much basic importance, is the factor of overhead. The builder has to maintain his offices, carry his executive personnel, and pay his men whether or not work is in progress. All these are employed if winter work is going on.

A further point often of greater importance from the financial standpoint than any other, although not always thought of, is the saving in capital on investment. If the work can be begun in October, November, December or January, instead of several months later, it means the operating of the plant or the occupancy of the building just so much sooner, thus earning interest and profit on the investment, which otherwise would have been lost.

All of these advantages affect the owner or builders of the structure. The advantage to the worker is even greater and more vital, however, because it greatly augments his earning power. It is the annual earnings rather than the daily wage that feed and clothe a man and his family. With more continuous work, there is correspondingly more money coming in. As a matter of fact, in order to further increase the tendency to building in winter, it might well pay the working man to work for lower daily pay during the months when many other costs are increasing.

In considering the pros and cons of this winter construction, we must consider very definitely, of course, whether there are any dangers of consequence. The principal materials which can be affected by the cold are hardening materials, such as plaster and cement. We must watch these closest. Wall plaster, for instance, if it freezes may as well be taken down entirely, in my opinion. It never sets up again. The natural cements, also, used so much in former years, — Rosendale cement, Louisville cement, etc. (probably most of you never used these), — were affected seriously by cold weather. Whether the natural cements that are coming into use again now are so severely impaired by frost has not been determined by conclusive tests. It is wise, however, to use great care with them in cold weather.

My first experience with frozen cement was on the job in North Carolina, which I mentioned when beginning my talk. They had built earlier in the winter a retaining wall of natural Rosendale cement concrete. In the spring this was all crumbly. I found out a few years later what the trouble was, from a similar experience on a job in Maine. This was in the building of a large power plant and mill. Stone walls for the mill were built about 1½ feet thick. Rough stone, blasted from the canals, was laid up in the winter with Rosendale cement mortar. This was some thirty-five years ago, before much was known about cold weather construction. When the mortar thawed in the spring, one could run a knife into it anywhere. They dug out the joints and plastered them up with Portland cement mortar brushed in. So far as I know, it is still standing.

At the same time they built several arches of cut stone, using Portland cement mortar, and these stood up satisfactorily, being thoroughly hard in the spring.

When we consider the effect of cold on Portland cement, it is sometimes difficult to distinguish between the effect of frost and the effect of low temperatures ranging between 32° F. and 45° F. or thereabouts. Many cases of near or actual failures have occurred from low temperature which has delayed the hardening. Probably many of you have come up against this. One of the earlier cases — a good many years ago, when reinforced concrete was not quite so common as it is now — was in the erection of an eight-story building in New York State. They laid the column footings early in December. They did not actually freeze, and yet in March I was called out there and I found the concrete in the footings so soft that it was very difficult to get a rough piece even for a hardening test. It crumbled in the fingers. The test, however, indicated that there were possibilities, and I advised them to wait for a while. A visit early in April showed that it had hardened a little. One could now break a little piece out, and, although still crumbly, it showed further indications of hardening, and so I advised them to go ahead with the building.

One of the footings was cut in pieces and quite a large piece was taken from the center and tested in July. It tested 2,500 lbs. per sq. in. instead of the required 2,000 lbs. per sq. in. for 1 : 2 : 4 cement, showing that it had hardened satisfactorily.

Other more serious cases have come up. One was in the Philadelphia Y. W. C. A. where a part of the building actually collapsed. The failure was due in part to the columns being frozen and the forms removed while the concrete was still apparently hard, and in part to an error of the architect in computing the size of the columns. It was never quite settled which caused the failure. Probably it was due partly to both causes.

At Lawrence, Mass., several years ago, there was a failure of a concrete groined arch reservoir which we traced to failure of the concrete which had been laid before the frost actually came. It failed when the forms were removed because the concrete had remained for weeks and months without hardening. There was also, as is often the case, a contributory cause due to poor quality of sand which contained some organic matter. Quite often, in fact, with this retarded hardening from cold weather, we find another circumstance such as the quality of the sand which, acting with the cold, further retarded the hardening. In Cambridge, some time ago, a number of concrete piles were placed which took a long time to harden. In this case it was not simply due to the cold, — in fact, it was in cold ground rather than in very cold weather that they were placed, — but it was due in part to the brand of cement used. Certain brands harden much more slowly than some other brands and require particular care if used in winter work.

In all such cases the concrete eventually hardens to a greater or less extent if supported by forms for a long enough period.

These illustrate some of the conditions that must be guarded against. One of the most interesting cases, which brought out clearly the reason why frozen concrete does not attain full strength, was in connection with the building here in Boston of a garage several stories high, where one of the floors had been caught by the frost. We cut out a sample of the concrete, and, from the test, concluded that it would never reach a strength greater than about 1,200 lbs. per sq. in. instead of 2,000 lbs. per sq. in. In breaking up pieces of concrete, I discovered on the smooth cement surface imbedding the stones that there was a distinct frost mark. It looked like the frost mark on a window pane — fine tracery. The action had forced the stone away from the cement by the projecting tracery. The body of the mortar was actually separated from the gravel stones, and it was evident that the concrete would never attain full strength, although there was a certain amount of adhesion left and a general binding of the particles together by the mortar.

Of course, the answers to all these cases is that the dangers can be prevented and the work can now be carried on successfully by the methods that contractors on modern buildings are using. Mortar or concrete can be protected from freezing by heating materials and encasing in canvas with heat underneath. For brickwork, the canvas goes up with the staging. It is a comparatively simple process to handle such protection.

The conclusions reached with reference to the advantages and disadvantages of winter construction, as brought out in this report, to which I have referred, are:

ADVANTAGES

1. Savings in labor cost through greater productivity of some 2½ per cent of total cost.
2. Cream of labor obtainable through the employment of the men in the various trades at a time when the supply exceeds demand.
3. Reduction in amount of poor work by incompetent men.
4. Labor more anxious to hold job in times of unemployment, and hence more efficient.
5. Seasonal price fluctuation in material prices, by which most material can be bought cheaper when needed for winter use.
6. Contractors willing to figure on closer margin to get business.
7. Three to six months' time often saved in interest on capital tied up.
8. Less freight congestion, resulting usually in better material deliveries.
9. No lassitude in workmen due to extreme heat of summer.

DISADVANTAGES

1. Extra cost of winter protection 1 to 5 per cent of total cost, average about 3½ per cent.
2. Fewer possible working days, due to the necessity of clearing away snow, or to extreme cold weather, thus tying up capital for longer period. This does not apply to buildings requiring a year or more to erect.
3. More difficult working conditions for some trades.
4. Occasional snowstorms that temporarily tie up traffic.

A contractor, summarizing his experience, writes:

> In my mind the broad thing to keep continually before us in connection with our advocacy of winter work is not only the unit of labor cost, which probably will be somewhat greater in winter than in summer, but the fact that this may be more than counterbalanced, frequently manifold, by lower material purchase, savings in interest on investment, and the benefits measured in dollars from the occupancy or use of the completed structure six months earlier.

This consideration of winter construction cannot becomplete without reference to the importance of *management* in construction work. Management, which includes the planning and scheduling of the work, the methods of purchasing materials and the handling of labor to best advantage, is a most important phase of any job, whether in construction or in factory operation. In cold weather, when we have various contingencies to provide for, the necessity of good management and forethought is particularly essential.

Walter C. Voss *

I WAS very much interested in what Colonel Thompson has just said regarding the various factors that enter into the question of whether or not we shall continue work in the winter, and I think he has covered in an able manner some of the points of which I was going to speak. I have, however, reserved this section of the winter construction idea, — What can be done with Portland cement or other materials used as binders in concrete or other work, to make sure that we won't have the troubles that we have had in manifold instances all over the United States and in other countries, due to extreme cold weather?

I recall last year when the Portland Cement Association — which, I might repeat, is very anxious to make sure that good concrete work is done all the time — found out that a large apartment hotel in Evanston, Ill., had failed. They sent a hurry-up call by telegram to all their

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* Portland Cement Association, 10 High Street, Boston, Mass.

District Engineers in every District Office, with instructions that each field engineer should consult all contractors on every field job, in order to try to suggest to him means of overcoming the dangers due to the freezing of concrete.

I want to say, in connection with this problem, that in my own practice I have, in two outstanding contrasted cases, gone to contractors operating in the winter, and have offered them the facilities of the Association, and they have given these typical replies: "I have been doing this for forty-five years and what can you tell me?" and "What ought I to do?" The second has always been a reply for which we are grateful. We have tried in such instances to put before the contractor all possible information based on his own particular job, plant and corps of workmen, which will facilitate the work and give assurance of satisfactory results without entailing excess cost.

The story of what actually happens is an important one in winter concreting or mortar work. As Colonel Thompson indicated briefly, when freezing sets in it doesn't make any particular difference what else happens to the concrete, providing the temperature at which it will set is maintained. If the hardening can take place before this freezing action does, you are well assured that your building is not going down. It is possible to get concrete to set with a short period of protection, and it is also possible to have the effect of 28 days of protection and to get the concrete to set so perfectly as to be sure that it will be all right during subsequent low temperatures. I have seen ordinary Portland cement concrete protected three days, the forms stripped, — freezing weather all the time, -- and in perfect shape.

We now hear a great deal about all kinds of accelerators — materials which will do everything from "killing corns" to "putting hair on the head." I want to say that no ordinary salt or anything added to concrete is going to reduce the freezing point sufficiently for us here in New England. You probably have yourselves experienced a drop of 40 degrees in less than six hours. It is true there are accelerators on the market which, acting under 60 or 70 degrees, during their period of acceleration or hardening will act perfectly, but during that period the concrete must be protected.

When concrete freezes one particular thing is taking place. Colonel Thompson has mentioned frescoes of frost impressed into the cement. That is one of the finest possible tests of frozen material. Here is just what happens. The grains of sand and the particles of aggregate have a slight film of water on their exterior surfaces. If this changes into frost or ice it prevents the hardening action from taking place. Maintained as ice it is as impervious as oil. The cement grains themselves are held inert. But that is where the trouble arises. We have a cold day, then a thaw; then the weather changes again and we get another cold day. The minute that ice changes to water we get the initial hardening action of concrete, and if the freeze comes soon enough before hardening is complete the concrete is gone.

I recall last winter a particular contractor on a job in Boston, whom we approached and who told us that he knew all about winter concrete work and we needn't bother about him at all. When he stripped his forms the top foot of every column in two or three of the outside bays slumped, bending the reinforcing bars. The owners were so anxious to get into the building that they put a four-ply roof on top of a film of ice. The Building Department condemned the work and told the building contractors to rip the whole job out. It was practically completed. We were then called in to try to save the building. After an examination I said that I would support the Building Department in its decision on the failure of the columns and beams, and that they would have to be reinforced. I suggested that the roofing materials be stripped completely. It was further suggested that a 6-inch bed of sand be placed upon the roof slab from parapet to parapet in each direction, and that the center of each beam and slab be shored. This was done. That frozen concrete is now housing a garage. It has set up and a sample has tested satisfactorily. I mention this particular instance for this reason, that I believe that with proper treatment it is perfectly possible to take a frozen piece of concrete which has been slightly thawed and then frozen again and bring it back to life.

I heard at the concrete convention held a year ago last February, in Chicago, the statement by a very prominent engineer that, in the case of the failure of an arch where there was a crack in the springing-line about $\frac{1}{4}$ in. wide he encased the crack with forms, filled it with fine sand, put 2 ft. of sand above that, and kept the sand inundated and left it 21 days. The crack healed up and this arch is in service today.

The specific material best known in connection with winter work is calcium chloride; it may be pure calcium chloride or calcium oxychloride. Calcium chloride has been very grossly misused in the city of Boston and in the United States. It should never be placed in crystal form right into the concrete. Calcium chloride itself should be dissolved in water to make a saturated solution, and 2 lbs. of calcium chloride in a saturated solution to a bag of cement is sufficient to give all the needed effect. I know that the salesmen for calcium chloride say that if you use one pound it will do so and so and 2 lbs. will do so much more, and they will run up to 5 lbs., and then the foreman says if 5 lbs. will do that, why 15 ought to enable me to take the forms out the next day. More than 2 per cent, or 2 lbs. of calcium chloride dissolved in water, is unnecessary in order to produce, with ordinary Portland cement, a concrete of 28-day strength in about three days. It is perfectly possible to do that where good concrete work is going on, but during those three days the concrete must have protection.

By protection we mean either an oil flame in the mixer, to keep the mixing unit hot; steam pipes for circulating steam through the piles of stone; or a half cylinder sheet iron fire-box, protecting and heating the stone and sand. Let the water be put into the mixer hot. That isn't all. When the concrete is placed on the job it should be protected either by covering it entirely with tarpaulins or other materials placed on top, or else short horses should be set over the top of the slab with tarpaulins over the horses. The slabs should be cast with holes at certain intermittent points. Salamanders should be placed below for recirculating the air underneath the slab just as well as on top. With any of these or with combinations of these precautions perfectly good concrete can be secured in three or four days, if an accelerator is used.

I wish to say this in conclusion. There are a number of engineers who feel that the Association which I represent is more or less concerned with ulterior motives in these matters. Well, we are to a certain extent. But you must remember that the more winter work, the more cement will be used, but if a building fails due to improper protection and because it has been affected by ordinary winter hazards, it will stop the use of concrete on some other work where it had been contemplated under similar conditions. We are just as much interested in passing on to you the experience of others in doing good concrete work in the winter time as we are in having you use cement at all.

Finally, just one word regarding our attitude and what we believe your attitude should be toward the winter construction. One of the most important items in the surveys that we have made of winter construction and its advantages, in addition to those outlined by Colonel Thompson, is the fact that if we want to keep moving as the particular dictate of our business energy indicates, we have got to build our building any time in the year, and if we don't we are delaying some other operations far more important and costly to the industry concerned than the small percentage of excess cost, offset as it is by the labor conditions Colonel Thompson has mentioned.

C. E. Patch*

I MUST say that I feel a bit out of place here, as I am not a concrete expert. I responded to the invitation to show a few slides and tell a bit about "winter work" at the Gulf Island Development of the Central Maine Power Company on the Androscoggin River just above Lewiston, Maine.

Preparations for "winter work" started back in September, 1925, before we knew definitely that we were going to build the dam. We first made a schedule of the concrete materials which would have to be used in the dam. We then made a survey of the country adjacent to the dam site to see whether there was stone suitable for crushing on the job. We then investigated the gravel pits and crushed stone quarries and their freight connections. Our schedule called for the pouring of some 30,000 cubic yards during the winter months, and a total of some 82,000 cubic yards.

We located a pit which contained gravel and sand in satisfactory quantity and quality, and which had a screening and washing plant of sufficient capacity but with digging and handling equipment which time studies showed were unable to handle what we would have to put through the mixers at the dam. We knew also that the time would come when the pit owner would have to stop washing and change his equipment to give us dry screened gravel. We accordingly arranged with him to purchase additional equipment if we placed the order with him.

As soon as we were awarded the contract we built a construction yard and proceeded to pile up a surplus of aggregate so that if anything happened at the gravel pit we would have a supply to fall back upon, when we were ready to begin pouring, and also to cover the period while the pit owner changed from washed to dry gravel.

The auxiliary piles of sand and gravel were brought in and unloaded from the cars by a gasoline caterpillar crane. Adjacent to these piles was the aggregate house into which were run the cars with the sand and gravel for current use. All surplus aggregate had to be rehandled into cars and dumped into the bins, the cost of this rehandling forming one item of winter expense. The aggregate bins were heated by vertical steam coils. There were undoubtedly at times frozen lumps in the aggregate, but by the time it was used it was in proper condition.

Measuring cars were run under bin chutes where the sand and gravel were picked up. The measuring cars then dropped the aggregate into skip cars which transferred it to the mixer hoppers. Cement was delivered to the mixer platform on a belt conveyor from the cement shed. Thus the men operating the mixers had all the materials brought to them mechanically. Just back of the mixer room was the stave water tower which was heated with steam coils and insulated. The concrete mixers discharged into cars hauled by Plymouth gasoline locomotives out on the trestle from which it was distributed through chutes. Later, at a higher elevation, it was distributed from a cableway.

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* Morton C. Tuttle Company, Park Square Building, Boston, Mass.

Another item of winter cost was the reheating of air from the compressors for use in running the air hammers. We did not buy commercial reheaters, but had them made up by the job mechanics out of pipe and fittings in the shape of cages in which coke fires were kept burning.

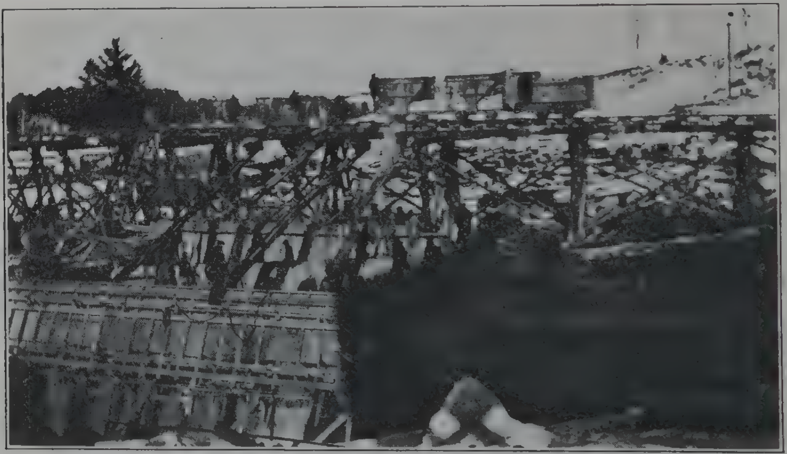

FIG. 1.—POURING CONCRETE AT 5° BELOW ZERO

Gulf Island Development of the Central Maine Power Company on the Androscoggin River. Constructed by Morton C. Tuttle Company

The typical method of protecting concrete during winter weather is indicated by the slide which shows canvas tentage over the floor of the power house flumes. The space was heated with salamanders just as would be done on the usual building job. Before making pourings any ice or snow on the surface to take the concrete was removed by the customary steam hose.

Fig. 1 shows the pouring of concrete at 5 below zero. You will notice that the men are bundled up for winter. Note also the vapor rising from the warm concrete material as it is coming down the chute.

A chart (Fig. 2) gives the record of temperatures and pourings during the winter months. The horizontal line marking the 32 degree, or freezing, line will be noted. The little blotches represent the days on which concrete was poured. We averaged pouring about 2,300 cubic yards each week. The great bulk of the winter's work, totalling about 30,000 cubic yards, was poured on days when the temperature was below freezing. The chart also shows the rapid changes in temperature, and the fact that on some days it was actually colder at noon than at 7 o'clock in the morning, emphasizing the remarks of a previous speaker as to the dangers to be met in doing winter work in New England. The only bit of frozen concrete which I can recall was found in the downstream side of the bulkhead section of the dam, where apparently the protecting canvas had not been carried down far enough and the concrete froze next to the forms. It was decided to leave this undisturbed, as it would be underneath the earth fill of the switch yard.

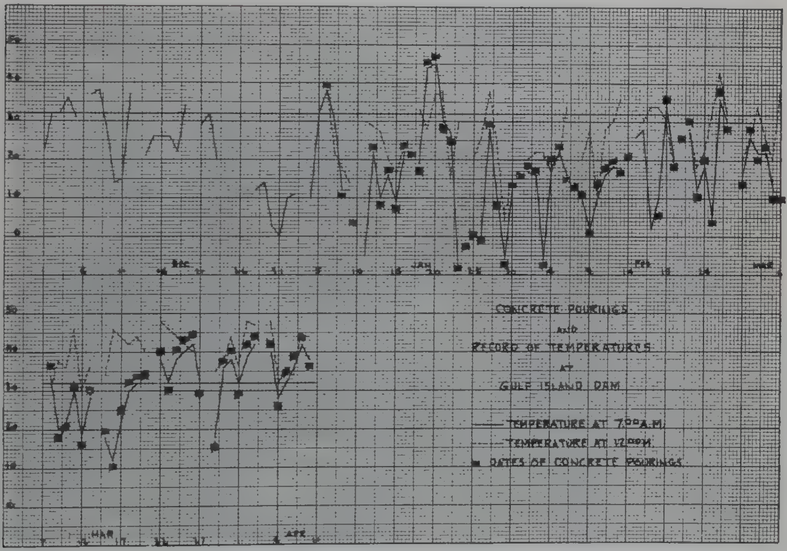

FIG. 2.—CONCRETE POURINGS AND RECORD OF TEMPERATURE

Gulf Island Development of the Central Maine Power Company

The total concrete poured to date is about 82,000 cubic yards.

So far as cost is concerned it checks very closely with the figures mentioned by Colonel Thompson. We do not have the final cost figures as yet, but totalling everything, including rehandling gravel, snow removal, cost of bins, firing boilers, etc., at this date the cost would amount to about 10 per cent of the total concrete cost, or, based on the total cost of the dam, it would be about 3 per cent. This may vary somewhat, of course, when we get the final cost.

In construction like this the matter of interest charges on capital invested plays an important part. The owners had already invested large amounts in land and flowage, and before the job had really got going we had spent something like $300,000 in preliminary work and plant equipment, so that the amount spent on winter work would be about offset by the interest, for the time lost due to not operating in the winter, on the money already invested at the time we started pouring. In addition, the owners are already getting returns from the power developed by the units installed here.

I think this is enough to give you an idea of what was done at Gulf Island. The interesting feature of it was, perhaps, that we scheduled the work so as not to be held up by lack of sand and gravel.

Discussion

QUESTION: I would like to ask Mr. Patch whether the concrete in that dam had any other protection than the wooden forms?

MR. PATCH: It had the customary canvas pulled down over the forms, and was heated with salamanders.

QUESTION: On the chutes, was there any tendency to chilling? They seemed to be fairly long.

MR. PATCH: None so far as I know. At least the concrete flowed successfully.

MR. E. G. LEE:* I wish to ask Colonel Thompson his opinion regarding the idea that if this propaganda to increase materially winter construction is really successful, most of the advantages will disappear. Labor will be fully employed so there will not be any unemployed excess available at a lower rate; materials will be used throughout the year so there will be no low winter price on materials. About the only advantages left will be the continuous use of construction organizations, and, in some cases, the saving of interest during construction, so the actual winter cost may be 15 or 20 per cent higher than the summer cost, instead of the 3 or 4 per cent which he mentioned.

COLONEL THOMPSON: This might be true if there were not other causes or forces along with it. The amount that a laboring man earns is not dependent on what he gets per day, but what he gets per year.

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* Hydraulic Division, Stone & Webster, Inc., Boston, Mass.

There are certain balances in wages which apply more or less automatically to different classes of work. For example, the bricklayer and the stone mason and the plasterer have abnormally high wages, for the reason that they work only a part of the year and have to have the high wage in order to get a fair total income through the year. When you level off the peaks, therefore, and give a man uniform work, you are making it possible at the same time for him to earn at a lower rate per day and get even more through the year, so he would be earning more than before and yet producing a saving on the job. It is the same with materials; for instance, again, where you have peak loads in the demand for materials, you have excess cost, and the prices have to be calculated accordingly. In other words, where you have to manufacture to take care of peak loads, you must have the capacity of the plant adapted to peaks. If you level off these peaks, you avoid this excess overhead and can manufacture cheaper and sell cheaper.

MR. LEE: If the summer peak in the costs of labor and materials is reduced or ironed out, the annual cost will be less and the summer cost will be less, so the actual difference between the cost of winter and summer construction will be greater than under present conditions.

COLONEL THOMPSON: This would be true if you could ever get them ironed out, but this is an impossibility unless the indirect advantages of winter construction outweigh the extra cost that will thus obtain. In other words, you can reduce the height of the peaks, but you will always have enough of a peak to affect the condition.

C. M. ALLEN:* In connection with winter material prices, I recently had an experience in getting hard pine which may be of interest. We ordered it on Saturday. Sunday came along as usual, Monday was Washington's birthday, and on Wednesday the first shipment came by trucks from Boston to Worcester, and every day thereafter until the order was filled. This was, for the most part, heavy, hard pine timbers, and had to be taken from the yards, planed on four sides and shipped. I got the impression at that time that the lumber company had just been waiting for this order. I do know that we got an exceptionally good price on it, and it certainly was quick delivery. We had a similar experience with two carloads of spruce from a company in Canada.

L. E. MOORE:† We have heard a great deal this evening about the construction industry and construction in winter, but your President (Prof. C. M. Allen) is the only one who has sounded a certain note which

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* Professor of Hydraulic Engineering, Worcester Polytechnic Institute, Worcester, Mass.; President, Boston Society of Civil Engineers.

† Consulting Engineer, Boston, Mass.

I would like to emphasize. Considerable has been said about concrete, its failures, the difficulties of using it in winter, and how it must be protected, but no one else has said a word about other materials of construction, such as wood and steel, with which construction can be carried on right through the winter without any particular precautions. This is just a thought I want to leave with you.

E. S. Dorr:* Isn't the difference in the chemical constituents of Portland cement a factor? Some cements are higher in lime, and one would naturally suppose that these would be less sensitive to frost. I would like to ask any of the speakers whether he thinks there is a material difference in cements, and if it is preferable to select cement high in lime for winter work.

Mr. Voss: I should like to say something on that. I didn't think it wise to consider one of these details in comparison with some of the other details which are more serious. I suppose there is a difference between the different brands of cement and their chemical composition, but as far as the American Society for Testing Materials is concerned, and through them all of the engineering societies in the country, there is a certain limit on the low and high of all those chemical constituents, and I think you will agree that the variations in temperature, the variations in the human element, the variations in the amount of water used, will have a great deal more to do with the matter of quick set, than any high lime or other high constituents. As far as engineers are concerned they are perfectly satisfied with any cement that will pass the A. S. T. M. standard, and I don't know of any particular failure with winter work with Portland cement that has been traceable to this question of the chemical constituents.

I remember hearing a prominent engineer in Worcester make the statement about four months ago, that if he could only test one material in the concrete he certainly would not test the cement, he would test the sand. It is quite possible to have one of the finest cements for quick setting and mix it with a sand high in tannic acid and have it a failure in the height of summer as well as in winter. So I think this question of the varying percentage of lime in different cements is greatly outweighed by the human elements.

Colonel Thompson: As I stated, there is quite a difference in Portland cement, in the different brands, for winter use, and I agree with Mr. Dorr that the lime characteristic has something to do with it. It is rather difficult, however, to attach exact significance to the chemical constituents of the various cements, because the compositions of different classes vary so greatly that a single element is difficult to differentiate. For winter work it is important to select your cement carefully.

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* Consulting Engineer, Boston, Mass.

I might cite one case where different sections of a retaining wall were laid up with different brands of cement. One section was deleteriously affected by the cold, while the adjoining sections were not, so I feel that this is one of the factors which should be considered. At the same time, I thoroughly agree with the point made by Mr. Voss that the sand is more important to the achieving of good hardening than the cement itself. Furthermore, the cement companies at the present time are gradually overcoming the slow hardening property.

QUESTION: I should like to ask, Mr. Voss, how would you take care of it if you are putting the base of your slab on the ground?

MR. VOSS: Where you are in contact with the soil, particularly certain soils, I think it is very wise to lay down some protection inside of the form if the ice is still in the ground. Another method which has been used is to strew steam pipes over the top of the slab and cover with tarpaulin.

QUESTION: Suppose the floor is being finished monolithic — waterproof so it couldn't go through?

MR. VOSS: Those represent peculiar conditions. Where a concrete freezes, thaws once and then comes to a set it is usually in perfect condition. I remember one particular case where a man took a sample of concrete and put it on top of his radiator until it was thoroughly dry, and when it was brought into court it crumbled under his thumb. You can destroy concrete by drying too quickly, even after it has been frozen.

M. N. CLAIR:* I would like to call attention to one agency that will help contractors in addition to those mentioned previously, and that is the U. S. Dept. of Agriculture, Weather Bureau. Their reports may be of great assistance if they are watched.

In the city of Battle Creek last week I had an experience with frozen concrete. On Monday the weather was fairly cold; the temperature was 43 degrees. A special type of concrete floor surface, about 1 inch thick, was laid on the fourth floor. It was laid because the weather looked good, and it was a nice day. The next day the temperature was still just about 43 degrees in the morning and the sky was cloudy. Later it started to rain. In the afternoon the temperature started to fall, and it fell rapidly. The rain changed to snow. The contractor then put up tarpaulins around the floor, but did not put in salamanders, as none were on the job. The floor got wet. Later the pools of water on the floor froze. The temperature went down to 28 degrees that night, and the next day there was a thaw again and the whole surface of that floor was scaled off. The water had frozen in the surface pores and had broken up the surface. Two days later they ripped out the floor surface. All the contractor need to have done to foresee the weather conditions would have been to go on Monday to the newspaper office at the corner where the Bulletins of the U. S. Weather Bureau were posted, and which gave a very correct and definite statement as to when the storm was coming and that the temperature was going to go down. They then could have had salamanders on the job and so protected that floor in time.

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* Testing Engineer, The Thompson & Lichtner Company, Inc., Engineers, Boston, Mass.

CONSTRUCTION COST ESTIMATING

By Clayton W. Mayers *

(Presented before the Designers Section, B. S. C. E., on November 10, 1926)

Construction cost estimating falls into two separate classes, namely, (*a*) the estimating of a complete building enterprise, usually carried out by general contractors in an effort to obtain a contract, and (*b*) the estimating of the cost of individual structural members for the purpose of making the most economical selection for incorporation in the structural design. This work is usually done by the designing engineer.

The designing engineer is seldom intensely interested in preparing an estimate of an entire building project, but he is intensely interested in making sure that the selections and options in his design are the most economical to construct. Inasmuch as there is no way to produce the most economical design without detailed cost comparative estimates being made, it is the purpose of this paper to point out the manner in which this work should be carried out.

Use of Uniform Estimate Sheets

Before doing this, however, it may be of some interest to describe briefly the method used in estimating the complete structure. No estimator of building construction can hope to carry on his work intelligently and comprehensively without adopting some uniform system in his work. The first step in this procedure is to use a paper uniformly ruled. An excellent form of ruled paper for this work has nine columns running vertically. In the first column the estimator writes the description of the work being scaled. Column No. 2 is called the "times" column, and in this column is indicated the number of similar pieces of construction work being scaled. Column No. 3 is the "length" column, and contains the length in feet of the pieces of work being scaled. Column No. 4 is the "width" column, and No. 5 the "height" column. In setting down figures in columns Nos. 3, 4 and 5, it should be borne in mind that decimals should not be used, fractions being substituted in their place. It will be found extremely convenient if these fractions are limited to twelfths, as most work is scaled in feet and inches; for instance, a piece of concrete 4′ 7″ square and 2′ 3″ high would appear on the scale sheet as $4\frac{7}{12} \times 4\frac{7}{12} \times 2\frac{1}{4}$. If this rule is observed the work will contain less errors than would be possible with the use of decimals. Column No. 6 is the "quantity" column, which contains the product of columns Nos. 2, 3, 4 and 5. Column No. 7 is a summary of all similar quantities. Column No. 8 contains the unit prices decided upon for this work, and column No. 9 the total money extension, which is added up at the bottom of the page to constitute the estimate in total.

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* Of Morton C. Tuttle Company, Park Square Building, Boston, Mass.

In order to make sure that all items have been scaled and priced up in the general estimate, it is usual to refer to some list which contains all items in a building. This should always be done, in order to make sure that no important item has been omitted from the estimate.

Cubical Contents and Floor Areas

One of the first steps in preparing a general estimate is to take off the cubical contents of the building, and the area of the various floors. If this procedure is made uniform practice it will have a tendency to develop a judgment along the lines of what should constitute a proper cost of building construction, and will very often serve as an excellent check on a total estimate. The measurements used in obtaining the cubical contents are usually from outside to outside of the building, and from the bottom of the basement floor to the roofing line (not the top of the parapet). Where there are irregularities, it should be borne in mind that the cubical contents should be considered as the measurement of the air displacement by the exterior dimensions of the building, exclusive of the footings and foundation piers. In the scaling of all the quantities on a job the rule of length, width and height should be carried out in the setting down of the figures. If this system is followed the scaling of form work can be done readily, without reference to the plans by simply referring to the concrete quantities. It is necessary, of course, to refer to the plans for the scaling of reinforcements. All other quantities should be taken off in their order of construction as closely as possible. A completed estimate should represent as nearly as possible every process of construction work carried out in the same order as the field superintendent would do the work.

The pricing up of an estimate involves a great deal of detail, and can only be done accurately with a background of experience. The costs used by an experienced estimator are, as a rule, the result of years of experience of himself, or some one in his concern who has had a long experience in the tabulation of actual unit costs of building construction.

IMPORTANCE OF COMPARATIVE ESTIMATES

Comparative cost estimating should be of major importance to every architect and engineer desirous of producing plans of maximum economy. It is not possible to prepare such plans by haphazard selections of the structural elements. Neither is it possible to decide upon the most economical form of construction by selecting one which from casual observation seems to satisfy every economical requirement. Alternate designs *must* be prepared in a sketch manner, and preliminary comparative estimates made of these designs in order to make sure that the most economical building is being put on paper. This applies to every part of the structural frame from the foundations to the roof. For instance, in the case of foundations, it frequently develops that a selection stands between a reinforced concrete footing and a plain concrete footing. Both types should be designed and estimated, in order to make certain which one should be shown on the drawings. Very frequently foundation conditions require piles either of wood or of concrete, and make the problem somewhat more complicated. In any event, all possible options should be designed, and estimates prepared, all of which should be done before plans are actually started. This applies especially to columns and floor designs. It is possible, as shown by designs and estimates in a particular instance, that in seven different designs for a structural concrete column the cost varied from $66 per column to $122 per column. All seven columns were of reasonably standard design, the variation in price being obtained by varying the mix of concrete and the proportion of steel, together with the diameter of the column itself.

In the design of beam and girder floors it is usually necessary to make preliminary sketches of various bay spacings and various beam spacings, and prepare estimates of each design before the building can be definitely laid out. Frequently an owner states that columns should be spaced on certain definite centers, and the engineer proceeds on that basis without further discussion. If a designer is to give an owner the maximum service, he should point out to him what would be the most economical spacing for his building, as in most instances the owner could adapt his uses to a column spacing which would insure him a more economical building. This is part of the service of a good structural engineer.

Unit costs used for cost comparative estimating, as explained above, need not necessarily be as accurate as those used for obtaining contracts. It is necessary, however, to use the same uniform prices throughout the studying of any one structural member.

Unit Costs for Comparative Estimates

For the purpose of comparative estimates I would suggest that you use the following unit costs in endeavoring to make a survey of the most economical selection in the design of structural elements:

Concrete Work

Concrete for footings, 1 : 2 : 4 mix, $11 per cu. yd. in place.
Concrete for columns, slabs and beams, $11.50 per cu. yd. in place.
Concrete mix in the proportions of 1: 1½: 3 add $1 per cu. yd. to above prices.
Concrete mix in the proportions of 1: 1: 2, add $3 per cu. yd. to the above unit prices.
Concrete in wall beams, upturned, which require ramp staging for lifting the concrete, add $1 per cu. yd.

Form Work

Measure contact surface.
Footings not exceeding 6 ft. in depth, 18 cents per sq. ft.
Grade beams and foundation walls, 25 cents per sq. ft.
Exterior columns without moulding, 30 cents per sq. ft.
Interior round steel column forms, including head, $14 each in place.
Flat slabs in multi-story buildings (4 to 6 stories) 18 cents per sq. ft.
Wall beams, 30 cents per sq. ft.
Parapet beams, plain on front side, 30 cents per sq. ft., measured both faces.
Cornice, or moulded type, 60 cents per sq. ft., measured both faces.
Steel reinforcement, average 4 cents per pound in place (3¾ cents for larger sizes to 4½ cents for small sizes).

Excavation

Hand work, 75 cents per cu. yd. to $4 per cu. yd., depending on soil. Average cost of excavation, $1.50 per cu. yd.

Sheeting

Measured contact surface, not over 6 feet deep, 30 cents per sq. ft.

Brickwork

In place, per cu. ft., $1.25 to $1.50.

Steel Sash and Glazing

45 to 50 cents per sq. ft. in place.

By using these prices in estimating comparative designs the engineer may be certain that he will be able to select the most economical structural element in each and every part of his building, and assure his client of a high grade and satisfactory service.

OF GENERAL INTEREST

PROGRESS IN ZONING

New Editions of "A Zoning Primer" and "A Standard State Zoning Enabling Act" Issued, prepared by the Advisory Committee on Zoning, appointed by Secretary Hoover

Revised editions of "A Zoning Primer" and "A Standard State Zoning Enabling Act, under which municipalities may adopt zoning regulations," are announced by the Division of Building and Housing of the Department of Commerce. These publications, both by the Advisory Committee on Zoning, appointed by Secretary Hoover, rank among the most popular pamphlets issued by the Department, more than 50,000 copies of each having been sold by the Superintendent of Documents.

The "Primer" explains in popular style the methods by which zoning protects property and health and avoids unnecessary scrapping of serviceable buildings. It was first issued in 1922. Since that date the number of zoned municipalities in the United States has increased from less than a hundred to more than 450, and the constitutional status of zoning has been upheld in thoroughgoing decisions of the highest courts of such states as New York, Massachusetts, Ohio, Illinois and California. There has been a wealth of added experience in the application of zoning to the most varied problems in many types of cities and villages. The revised edition takes into account the developments of the past four and a half years, and includes a list of zoned municipalities by states.

"A Standard State Zoning Enabling Act" has been embodied in the laws of 20 states since it was first issued in preliminary form three years ago. Court decisions on cases arising under it have been studied with the greatest care, and the only change made in the text is in the section on "Enforcement and Remedies," where the other means of securing compliance with zoning ordinances are strengthened by adding the following:

> The local legislative body may provide by ordinance for the enforcement of this act and of any ordinance or regulation made thereunder. A violation of this act or of such ordinance or regulation is hereby declared to be a misdemeanor, and such local legislative body may provide for the punishment thereof by fine or imprisonment or both. It is also empowered to provide civil penalties for such violation.

Some of the introductory statements have been revised, and, in response to requests, a new footnote has been drafted on the subject of empowering communities to exercise zoning control over areas which are adjacent to the city's limits, but do not lie within any other incorporated city or village.

"A Zoning Primer" records that —

> on January 1, 1926, the 426 zoned municipalities in the United States had a total of more than 27,000,000 inhabitants, exceeding half the total urban population of the United States. Thus a majority of all people living in incorporated places with 2,500 or more people now enjoy the protection and other benefits of zoning. On January 1, 1921, there were only 35 zoned cities and towns with less than 11,000,000 population, so that in a period of five years the number of zoned municipalities increased more than twelvefold.
>
> Undoubtedly the most convincing statement which could be made in regard to the value of zoning is that so many of the large cities of the United States now feel that it is impossible to continue to develop further without the adoption of a building zone plan. New York, Chicago, Boston, Baltimore, Pittsburgh, Los Angeles, Buffalo, and San Francisco head the list of the large cities that already have zoning ordinances in operation. On January 1, 1926, 48 of the 68 largest cities in the United States, having in 1920 a population of more than 100,000 each, had adopted zoning ordinances, while most of the others had zoning plans in progress. Moreover, it is not alone our larger cities which realize the necessity for timely regulation of the uses of property. Hundreds of the smaller cities and towns, especially in California, Illinois, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Wisconsin, but also in many other states, have passed zoning ordinances, and hundreds more were reported as having zoning plans in progress.

These publications may be secured upon application to the Government Printing Office, Washington, D. C. (Price, 5 cents each.)

Library Books Missing

In a recent check-up of the books maintained in the Affiliation Library, a number of books were missing with no record of their having been charged out in the proper manner. The books in the Library are the property of the Boston Society of Civil Engineers, and at the time the various societies affiliated, these books were made available for the use of all Affiliation members. During the past few years the B. S. C. E. has added very materially to the Library.

It is possible that some of these books were taken out by members of the different societies, and that they neglected to sign for them. The following list of books missing is published herewith, in the hope that through the co-operation of the membership these books will be returned to the Library:

Merriman, American Civil Engineers' Handbook; Wynne, Handbook of Engineering Mathematics; Hool & Johnson, Concrete Engineers' Handbook; Ketchum, Structural Engineers' Handbook; Bland, Handbook of Steel Erection; Harger, Highway Engineers' Handbook; Kidder & Nolan, Architects' and Builders' Handbook; Hoffman, Heating and Ventilating Handbook; Colvin, American Machinists' Handbook; Croft, American Electricians' Handbook; Hool & Johnson, Handbook of Building Construction (Vol. 1).

Bishop, Structural Drafting; French, Engineering Drawing; Swain, Young Man and Civil Engineering; Grant, Practical Accounting for General Contractors; Breed & Hosmer, Surveying (Vol. 1); Urquhart & O'Rourke, Design of Concrete Structures; Hool, Reinforced Concrete Construction (Vols. 1 and 2); Hool, Elements of Structures; Skinner, Details of Bridge Construction; Barnes, Estimating Building Costs; Dingman, Estimating Building Costs; Dingman, Plan Reading; Moyer & Wostrel, Practical Radio.

Section Prize Papers

On April 12, 1924, the Board of Government of the Boston Society of Civil Engineers voted "to present a prize for a worthy paper in each section by a member of that section." These awards consist of books selected by the recipients.

Awards have already been made at the Annual Meetings, as follows:

March 25, 1925. *Designers Section Award* to William D. Henderson, for paper on "Structural Design Features of a Hydro-Electric Development."

March 17, 1926. *Sanitary Section Award* to F. William Haley, for paper on "Recent Additions to the Sewerage System and Disposal Works of Framingham, Massachusetts. *Designers Section Award* to Barzillai A. Rich and William Walter Bigelow, for paper on "Stresses in a Composite Member Subjected to Bending and Direct Stress."

Doubtless many of the members of the Sections have material which would make interesting papers for presentation. If you have, drop a line to the Clerk of the Section, telling about it. Don't wait to be asked! Just remember — some information you have collected, or some experience which you have had, may seem trivial or commonplace to you on account of your familiarity with it, but the presentation and publication of it may be of inestimable value to a fellow member.

The Executive Committees of the various Sections urge you to co-operate with them in securing such papers.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

November 17, 1926. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, Boston, and was called to order by the President, Charles M. Allen, at 7.15 P.M. There were 140 members and guests present.

The minutes of the joint meeting with the Student Civil Engineering Societies on October 20, 1926, were approved as printed in the November Journal.

The Secretary announced that the Board of Government had elected the following to membership in the Society:

October 20, 1926. *Members:* Charles L. Johnson, Morgan L. Woodruff. *Associate:* Bartil W. Lindstrom. *Junior:* Arthur E. Howard.

November 17, 1926. *Members:* Louis A. Chase, Frederic W. Guerin, Albert J. R. Houston. *Juniors:* Herbert G. Davis, Roger F. Duwart, Robert S. Foster, Jr., John O. Harmaala, Allison L. Killam, Charles W. Knowlton, James A. Leussler, William H. Pitman, Joseph D. Popkin, Albert A. Roberts, Foster R. Spofford, Karl H. Wilber, Norman M. Winch.

The President announced that Henry Beecher Wood, a member of the Society since June 20, 1888, had died on September 28, 1926. He stated that a committee would be appointed to prepare a memoir.

The Secretary reported that at the regular meeting of the Society on September 22, 1926, it was voted to authorize the Board of Government to use the income from the Permanent Fund for current expenses. In accordance with the By-Laws, it was necessary that this vote be passed also at this meeting. The Society then voted:

That the Board of Government be authorized to use the income from the Permanent Fund for the current year as they deem necessary in payment of the current expenses of the Society.

The President then announced that the subject of the meeting was "Winter Construction," and introduced Col. Sanford E. Thompson who addressed the Society on the general features involved in winter construction, and told of the work done by the President's Unemployment Conference which resulted in the publication entitled "Seasonal Occupation in the Construction Industries." Colonel Thompson had been actively connected with the preparation of the material for portions of this publication.

Mr. Walter C. Voss, of the Portland Cement Association, then spoke on this subject, dealing particularly with cement and binders used in construction work.

Mr. C. E. (Dan) Patch, of the Morton C. Tuttle Company, described the plant and methods used by the Tuttle Company in concreting in cold weather on the Gulf Island Development of the Central Maine Power Company. Mr. Patch's talk was illustrated with lantern slides.

Following the presentation of these papers, a number of questions were asked and a general discussion of the subject held. At the conclusion of the meeting, a rising vote of thanks was given to Colonel Thompson, Mr. Voss and Mr. Patch for their courtesy in addressing the Society.

Meeting adjourned about 9 P.M.

J. B. BABCOCK, *Secretary.*

Sanitary Section

OCTOBER 27, 1926. — A regular meeting of the Sanitary Section was held in the Library of the Affiliated Technical Societies of Boston on Wednesday, October 27, 1926. Preceding the meeting, 32 members of the Section met at Marston's Dining Room for dinner.

The meeting was called to order by Chairman Gilcreas at 7.20 P.M. The reading of the minutes of the previous meeting and of the summer excursion was omitted. Mr. Almon L. Fales, of Metcalf & Eddy, was introduced as the speaker of the evening, his subject being the Method of Sewage Treatment Adopted for North Toronto, Can. Mr. Fales explained the details of the new sewage treatment plant which it is proposed to build at North Toronto. The plant is to consist of storm water standby tanks, racks and grit chambers, preliminary sedimentation tanks, activated sludge aeration and sedimentation tanks, separate sludge digestion tanks, with provision for controlling the reaction of the sludge, and glass-housed sludge beds. The gases from the sludge digestion tanks are to be collected and burned, the heat utilized for maintaining suitable temperatures for sludge digestion and for other purposes.

During the discussion which followed the talk Mr. Fales requested Messrs. Flood and Chase, who had been associated with him on the work, to explain some of the special features not covered by his talk. Others taking part in the discussion were Messrs. Dorr, Fair, Allen, Tyler, Gage and Porter.

There were 42 present at the meeting. Meeting adjourned at 8.40 P.M.

R. W. HORNE, *Clerk.*

Designers Section

NOVEMBER 10, 1926. — The regular November meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6.10 P.M. in the Affiliation Rooms. The minutes of the October meeting were read and approved. The tentative subjects for future meetings were then read.

The chairman introduced Mr. Clayton W. Mayers, of Morton C. Tuttle Co., who spoke on "Procedure in Making Estimates of Cost of Construction." A general discussion followed.

There were 55 members and visitors present. The meeting adjourned at 7.35 P.M.

SCOTT KEITH, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[Dec. 15, 1926]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

Brousseau, George Fred, Boston, Mass. (Age 22, b. Putnam, Conn.) Graduate of Mass. Inst. Tech. At present is junior engineer with Metcalf & Eddy. Refers to J. B. Babcock, H. K. Barrows, C. E. Carter, S. T. Drew, C. W. Rolfe, A. L. Shaw.

Burkett, Frank Edwin, Reading, Mass. (Age 19, b. Rockland, Me.) Educated in the public schools of Camden, Me. Entered Northeastern University in January, 1925. During the co-operative periods has been employed by Aspinwall & Lincoln. Refers to C. O. Baird, F. L. Cheney, C. S. Ell, G. A. Haskins, J. W. Ingalls, W. E. Nightingale.

Magee, Arthur Malcolm, Taunton, Mass. (Age 19, b. Taunton, Mass.) A student at Northeastern University, in civil engineering. Has worked as rodman for Hartley L. White and R. L. Hayward. Refers to W. J. Alcott, Jr., C. O. Baird, G. H. Haskins, J. W. Ingalls, G. H. Meserve, W. E. Nightingale.

For Transfer from Grade of Junior

Randlett, Frederick James, Dorchester, Mass. (Age 27, b. Boston, Mass.) Educated in public schools of Boston and graduated from Wentworth Institute, class of 1920, and evening class of 1921. Also took an evening course in estimating at Franklin Union in 1922. In the summer of 1919 was employed by the Aberthaw Construction Company, as plan clerk; summer of 1920 was assistant engineer in town of Milton. From the fall of 1920 to summer of 1922 was employed by F. H. Randlett as carpenter foreman; from 1922 to date employed by the Edison Electric Illuminating Company as a conduit inspector. Refers to E. L. Dearborn, C. F. Joy, Jr., O. F. Mann, A. G. Martin, E. A. Varney. (*Elected to grade of Junior, April 26, 1922.*)

NEW MEMBERS

Members

Louis A. Chase, 100 Hermon Street, Winthrop, Mass.

Albert J. R. Houston, 44 The Fenway, Boston, Mass.

Juniors

Leon R. Briggs, 87 Audubon Road, Suite 9, Boston, Mass.

Herbert G. Davis, 206 Pleasant View Avenue, Braintree, Mass.

Thomas A. Giblin, 49 Longwood Avenue, Roxbury, Mass.

Allison L. Killam, 30 Webster Street, East Lynn, Mass.

James A. Leussler, 8 Child Street, Jamaica Plain, Mass.

Joseph D. Popkin, Northeastern University, Boston, Mass.

Foster R. Spofford, 98 Professors Row, Tufts College, Mass.

Karl H. Wilber, 74 Pleasant Street, Brookline, Mass.

DEATH

James E. Stone . November 23, 1926

BOOK REVIEW

*"Hydraulics," by Hector J. Hughes, Professor of Civil Engineering, Harvard University, and Arthur T. Safford, Consulting Engineer; Revised and Abridged, 1926, by Mr. Safford. The Macmillan Company. 356 pages. Engineering Science Series, Edited by Dugald C. Jackson and Earle R. Hedrick.**

The revised edition of this work is somewhat abridged in comparison with the previous edition of 1911, and yet does not suffer thereby. The older edition contained 450 pages of text compared with 330 in the new.

An introductory chapter has been added covering the history of hydraulics. This is an excellent, concise summary of the development of the understanding of hydraulic phenomena from the time of the Roman system of waterworks. Most of the remaining chapters have been shortened and improved by the omission of the discussion of matters of little practical use or of tables of information not now generally used, such as the N. E. W. W. A. standards for cast iron pipe, and of data and tables readily obtained from handbooks. New data have been added on the flow of water in steel and concrete pipes, and new observations on river flows of considerable magnitude.

Attention is called to the practical application of principles governing irregular flow in open channels, whose importance has been more and more recognized recently, — for example, in the open Venturi flume, hydraulic jump, etc. The author might well have included a more complete discussion of these principles rather than to leave the possible impression of mere chance in such phenomena.

The author has made a very wise choice in the selection of many practical applications of hydraulic principles, such as the pitometer tube, Venturi meter, orifice, nozzle and weir measurements. The chapter on current meter measurement has been rewritten and improved to a considerable extent.

The chapter on water wheels has been entirely rewritten and modernized in brief but excellent fashion, as would be expected from the authors of this work. The matter dealing with pumps is perhaps too brief in that it does not show typical characteristic curves for the common centrifugal type.

On the whole, the work is excellently adapted to its primary purpose as a textbook of practical hydraulics, and is also very valuable to the practising engineer.

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* Reviewed by Karl R. Kennison, Designing Engineer, Metropolitan District Water Supply Commission, Boston, Mass.

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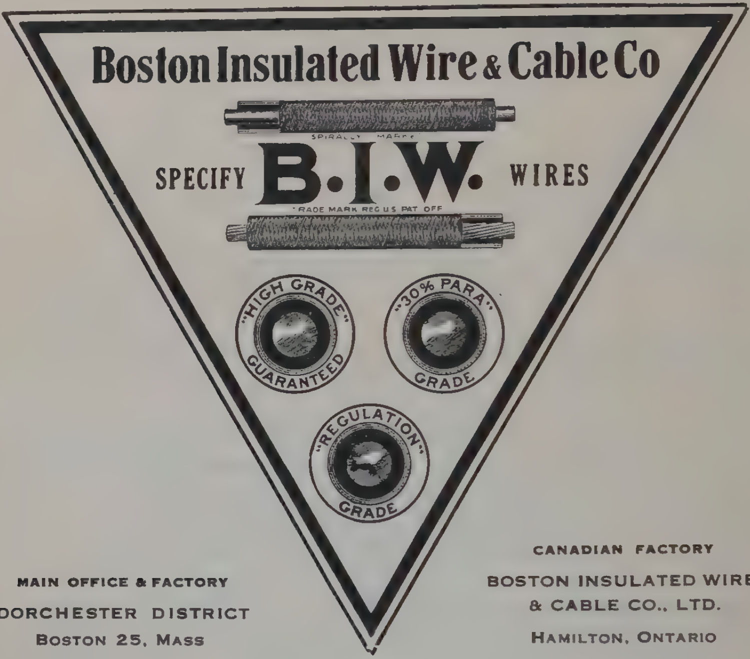

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